Civil & Commercial Applications Project (CCAP): Evaluation of IKONOS Geopositional Accuracy

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Study Objective

- The objective of this study was to determine whether a sample of IKONOS orthorectified and stereo products met the vendor stated geopositional accuracy specifications

SPACE IMAGING PRODUCT NAME	PROCESSING LEVEL	HORIZONTAL ACCURACY, CE90	VERTICAL ACCURACY, LE90
Carterra Pro-Ortho	Level 4	10.2 meters	N/A
Carterra Precision-Ortho	Level 4	4.1 meters	N/A
Carterra Stereo Pair	Level 2	25 meters	22 meters

Approach

- The evaluation of geo-positional accuracy of IKONOS orthorectified and stereo imagery products is based on a comparison to well surveyed Ground Control Points (GCP)
- The GCPs are part of a global network of NIMA surveyed Test and Evaluation (T&E) points
- Evaluation support provided by NIMA's Precise Imagery Exploitation Branch (GITA)
- NIMA/GITA geospatial analysts (GIs) performed the point derivation for the entire data set
- Imagine, Socet Set, and PCI software packages were used to measure the coordinates in the imagery products
- Results were sent back to CCAP for analysis and reporting

Imagery Used

- Stereo imagery for twelve targets were tasked against T&E survey sites
  - The accuracy of the T&E points varies with the particular target, but is generally within one meter in latitude, longitude, and elevation coordinates
- All twelve stereo pairs were also obtained as Carterra Pro-Ortho
- Five of these (all from within the continental US) were also obtained as Carterra Precision-Ortho
- Both levels of orthorectified imagery were provided in GeoTIFF format
- IKONOS panchromatic stereo pairs were provided in NITF 2.0 format

Orthorectified Products

Scene	Pro-Ortho Product ID Number	Prec-Ortho Product ID Number	Acquisition Date	Mean GSD, meters
Abu Musa TC	64412	---	20-Feb-01	0.82
Antananarivo MA	62449	---	13-May-00	0.86
Christchurch NZ	64527	---	12-Feb-01	0.87
Fallon NV	62331	64404	16-Jan-01	0.84
Hickam AFB HI	62440	---	28-Feb-00	0.82
Keflavik IC	66521	---	13-Mar-01	0.86
Miami FL	62267	64502	28-Apr-00	0.85
Sioux City IA	62326	64398	28-May-00	0.85
St.Simons Isl GA	62329	65690	12-May-00	0.83
Sunnyvale CA	62337	62334	27-Jan-00	0.84
Utapao TH	62594	---	16-May-00	0.82
Villa Delores AR	63951	---	23-Sep-00	0.86

Stereo Products

Scene	RPC Tag	Product ID Number	Acquisition Date	Mean GSD, meters, (right image)	Mean GSD, meters, (left image)
Abu Musa TC	RPC00A	61943	3-Oct-00	0.87	0.98
Abu Musa TC	RPC00B	74158	3-Oct-00	0.87	0.98
Antananarivo MA	RPC00A	62164	29-Apr-00	0.98	0.88
Christchurch NZ	RPC00B	67064	27-Apr-00	0.98	0.88
Fallon NV	RPC00A	62016	27-Apr-00	0.95	0.95
Hickam AFB HI	RPC00A	61659	15-May-00	0.97	0.83
Keflavik IC	RPC00B	65830	13-Mar-01	0.93	0.88
Miami FL	RPC00A	62071	28-May-00	0.97	0.94
Sioux City IA	RPC00A	61665	28-May-00	0.85	0.92
St.Simons Isl GA	RPC00A	61667	3-Jun-00	0.84	0.9
Sunnyvale CA	RPC00B	68447	17-Apr-01	0.91	0.94
Utapao TH	RPC00A	62161	16-May-00	0.95	0.82
Villa Delores AR	RPC00B	50643	23-Sep-00	0.9	0.86
Villa Delores AR	RPC00A	64654	23-Sep-00	0.9	0.86

Methodology -- Orthos

- NIMA T&E point graphics are used to locate the T&E points in each scene.
- Ortho products were imported into the Windows-based ERDAS Imagine 8.4
- T&E points were measured and the ground coordinates were computed
- The difference between the surveyed (published) value and the measured value was obtained as seconds of arc and converted to meters using published NIMA transformation procedures
- These values were then compared to the published T&E coordinates and elevation

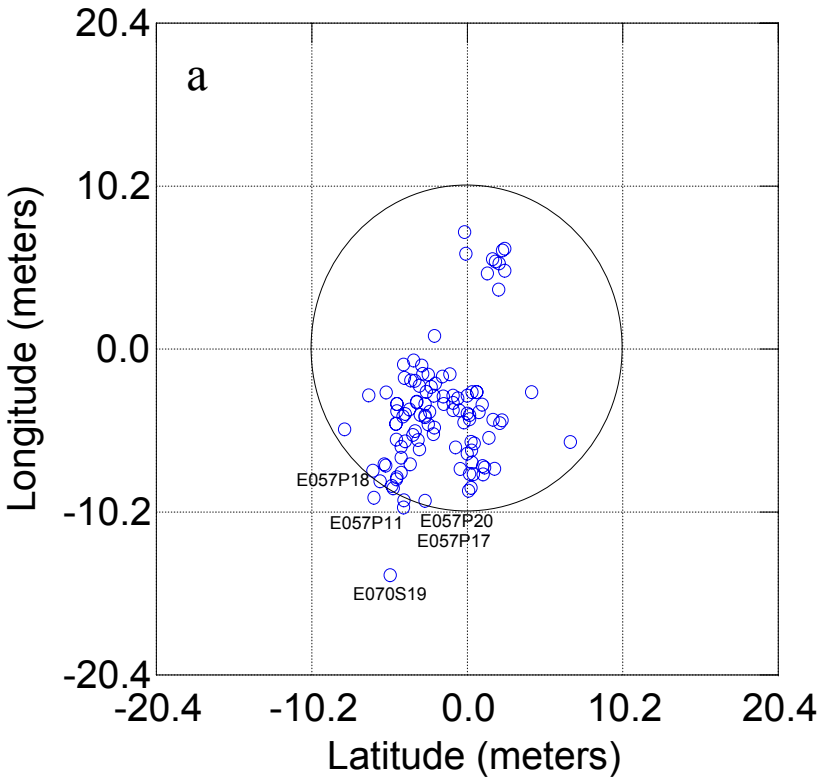
Methodology -- Stereo Pairs

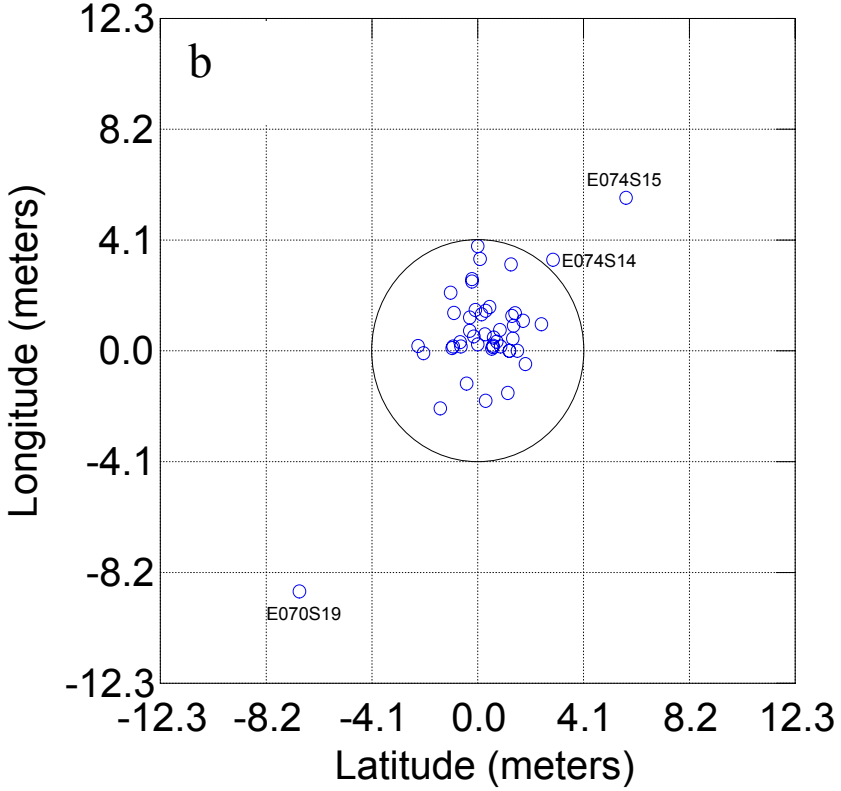
- Stereo pairs were loaded into a Unix-based Socet Set 4.3.1.
- NIMA T&E point graphics are used to locate the T&E points in each scene
- Measured latitudes and longitudes were saved to text files and imported into GeoDiff software
- GeoDiff calculates the difference between the measured geographic coordinates and the published coordinates for a given GCP and reports the difference in a designated unit of measurement
- These values were then compared to the published T&E coordinates and elevation

Ortho Results

- **Pro-Ortho Absolute Accuracy**
  - 103 of the 108 points (95%) are within the 10.2 meter specification
  - 90% of them have accuracies better than 9.4 meters
- **Prec-ortho Absolute Accuracy**
  - 43 out of the 46 points (93%) are within 4.1 meters
  - 90% of the points have accuracies better than 3.6 meters.
- **Outliers**
  - Three of the five outliers for points measured in the Pro-Ortho images from elevated features
  - All three outliers for points measured in the Prec-Ortho images were taken from elevated features

Pro- and Prec-Ortho CEs





a) Pro-Ortho Product

b) Prec-Ortho Product

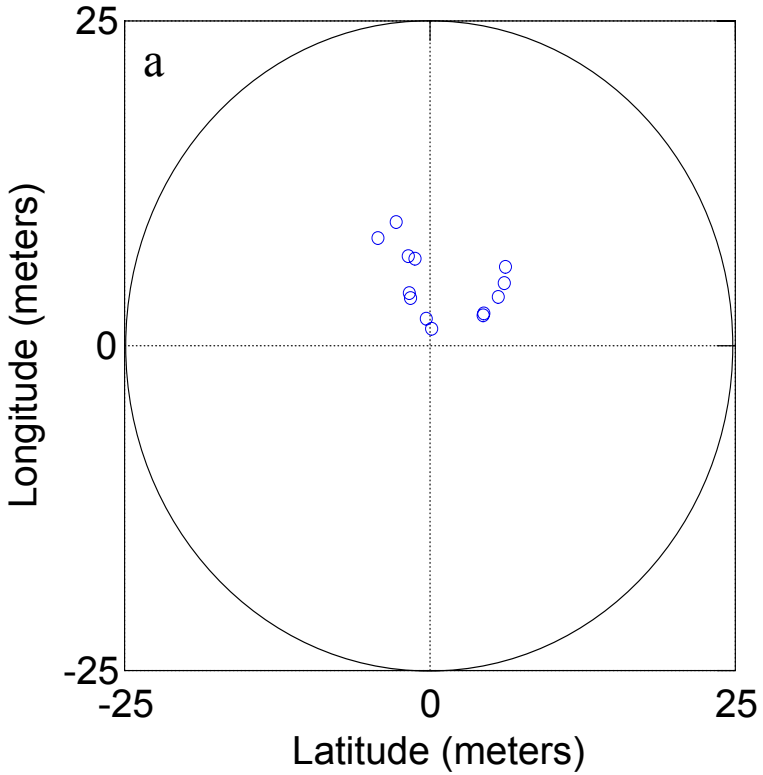
Ortho Relative Accuracy

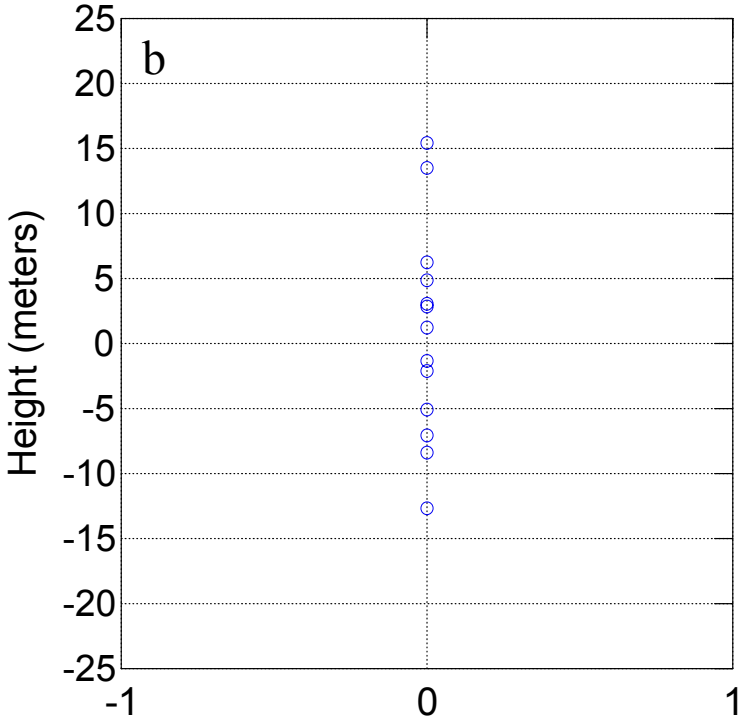
- Mean relative accuracy of 12 Pro-Ortho cases is 1.6 meters (437 measured segments)
- The highest calculated relative accuracy for this sample is 4.8 meters and the lowest is 0.77 meter
  - includes the measurements between all points including those that fell outside the absolute accuracy radius described by the CE90 specification (outliers/blunders)
- Mean relative accuracy of 5 Prec-ortho cases is 1.9 meters (190 measured segments)
- The highest calculated relative accuracy for this sample is 3.44 meters and the lowest is 0.93 meter
  - As with the Pro-Orthos, this calculation of relative accuracy includes the measurements of points identified as blunders

Stereo Results

- All 13 stereo point sets (12 cases, one duplicate) fall within the horizontal accuracy specification of 25 meters
  - 90% of the measurements are within 9.1 meters
- All 13 elevation measurement sets fall within the vertical accuracy specification of 22 meters
  - 90% of the elevation measurements have vertical accuracies better than 13.1 meters

Stereo Pair CE and LE





a) CE 90%, Stereo Pairs

b) LE 90%, Stereo Pairs

Conclusions

- The IKONOS geopositional products investigated in this study fall well within Space Imaging's stated specifications for absolute horizontal and vertical accuracy
- The products investigated in this study will meet the absolute accuracy requirements for use in the creation of several NIMA mapping products
  - Orthos generated from Stereo Pairs would be expected to have a similar accuracy, depending on the quality of the DEM used
- The relative accuracy of the image products used in this study should exceed most NIMA requirements
- While accuracy requirements may be met or exceeded, area coverage requirements may challenge the NIMA customer in terms of tasking, expense, and length of delivery time

Acknowledgments

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